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Seeking alternative textile resources from the perspective of recycled blankets

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Abstract

Blankets, one of the most important textile products, constitute a traditional product group with a wide range of uses. Blankets which are produced from different types of fibres and yarns, with different patterns and constructions are preferred by the customers for many purposes such as warmth and protection and it is possible to manufacture different types of blankets like in various sizes. The rapid increase in consumer demands in recent years has led manufacturers to look for new sustainable resources in addition to natural resources. For this reason, in the last few decades academic interest focused on sustainability studies like manufacturing recycled textile materials and determination of their properties. Nowadays, pre-consumer and post-consumer recycled fibres and yarns are utilized up to a certain degree in many product groups such as carpets, blankets, socks, denims, etc. Investigation of dimensional stability, weight loss, and colour changes of blanket manufactured from recycled yarns under repeated washing conditions was the aim of this study. For this purpose, firstly, dimensional changes after five washing cycles were determined. Gradually, weight loss with repeated washings were measured. And finally, changes in colour of blanket after repeated washing cycles were calculated by colour difference value (ΔE) considering CIE lab coordinate values (lightness, greenness-redness, and blueness-yellowness). Besides, this study shed a light on the manufacture of sustainable textile materials.

Keywords: Blanket, Recycling, Textiles, Colour measurements, Repeated washing

1 Introduction

Blankets, one of the most important textile products, constitute a traditional product group with their widespread use. Blankets can be manufactured different types of fibres and yarns, with a variety of designs and structures, and they are used for many purposes such as warmth and protection. It is also possible to produce blankets in various sizes, thickness, with or without raised effect, comfort properties. Blending fibres in textile products provides advantages in terms of improving product properties and reducing costs by using various characteristics of different fibres (Miao 2018).

With the industrial revolution, developments in the manufacturing industry have enabled textiles to be produced faster and at more affordable prices, resulting in high levels of textile waste (Bhatia, Sharma, and Malhotra 2014).

In recent years, blankets can be used in four seasons, including the summer months. For this reason, many factors such as thermal insulation properties, handle properties (Inoue and Kurata 2002), washing performance and colour and pattern properties of blankets are important. Recycled fibres from textile waste are used for the manufacture of low-quality products including blankets, carpets, and shawls (Jain and Gupta 2016).

There is limited research on blankets in the literature and it is seen that most of the studies are related to the smoothness and thermophysiological properties of blankets. Umbach (1986) investigated the thermophysiological properties of wool and acrylic-cotton blended blankets revealed that the woollen blanket provides a higher degree of thermal insulation compared with the acrylic cotton fibre blended blanket and it has better moisture transport properties under stationary conditions, and better moisture absorption and buffering capacity under temporary conditions than the acrylic-fibre-cotton blended blanket. Consistent with these results, in subjective evaluations, test participants evaluated woollen blankets as better in terms of thermophysiological comfort (Umbach 1986). Kumpikaitė et al. (2022) investigated the shrinkage according to Standard LST EN ISO 3759:2011 and air permeability according to Standard LST EN ISO 9237:1997 specifications of two series regarding as woven blankets from 100% woollen yarn and regenerated woollen yarn in the weft and woollen yarn in the warp directions. The samples were treated finishing considering steps as soaping, fulling, washing, softening (at 40 °C), wet raising, drying, and dry raising. According to the results of their statistical study, type of the raw material both in warp and weft directions didn't affect the shrinkage while the shrinkage values were influenced from the weave. Also, when the shrinkage results were evaluated for warp and weft directions, the shrinkage in the weft direction was higher than the warp direction. This situation was depended due to the less tensioned weft threads compared with the warp yarns; the looser weft yarns had more possibility to be shrunk (Kumpikaitė et al. 2022).

Shanmugam et al. (2021) examined the properties of wool-cotton blend blankets at different ratios. They emphasized that the thermal resistance of the blankets decreased, the cold feeling increased and the smoothness improved with the increase in the cotton ratio in the blend. In the study (Shanmugam et al. 2021), the colour values of the fabrics were analysed with the computer colour matching program, and it was stated that the shade depth of 100% wool fabric was darker than 70/30 wool cotton fabric. The compression properties of blankets were predicted by Inoue and Kurata (2002) based on fibre twist properties and blanket structure. In another study on blankets, mathematical equations based on compression and surface attributes, thickness, weight, and thermal parameters were developed for the prediction of handle properties (Niwa, Inoue, and Kawabata 2001).

The rapid increase in consumer demands in recent years has led manufacturers to search for new sustainable resources in addition to natural resources. Among the studies on the recycling of textile wastes and sustainability, which is an important issue today, studies on recycling blankets are important. In this context, Tian et al. (2021) evaluated the environmental load, cost and social impact of blanket production from recycled PET. In the study in which the thermal comfort properties of the blankets produced from recycled and original fibres were compared, and it was found that there was no statistical difference in the thermal conductivity

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and thermal resistance values of the blankets produced from recycled fibres and original fibres, and the thermal absorption value of the blanket produced from recycled fibres was lower than the blanket produced from original fibres (Celep and Yüksekkaya 2012).

2 Materials and Methods

The raised blanket, that is kindly provided from a local company from Uşak (Türkiye), and it was composed of 42 Tex warp recycled polyester yarn and 241 Tex recycled polyacrylonitrile, viscose and cotton blend weft yarn. The weave of the blanket is given in Figure 1. The weight of the fabric was determined according to the ISO 3801:1977.

In order to investigate the usability of recycled blankets; dimensional stability, weight loss, and colour changes after 5 cycles of washing was evaluated. First, blankets were conditioned under atmosphere conditions (20±2 °C temperature and 65±5% relative humidity) for 24 h. Blankets were cut to a square shape of 50 x 50 cm^2 according to the ISO 3759:2011 for determination of dimensional change. Calculation of dimensional changes were made according to the ISO 5077:2007. Washing was performed at 40 °C, 30 min, without tumble drying and with ECE detergent (without optical whitener and phosphate) as stated in TS EN ISO 105-C06:2010. CIE (Commission Internationale de l'Eclairage) Lab coordinate values were measured Shimadzu UV 2600i Spectrophotometer (UV-Visible DRS (Diffuse Reflectance Spectra). The measurements were performed under reflectance measurement mode, with fast scan speed and at a wavelength range of 200-800 nm. The changes in dimensions, colour and weights of the blanket were given either graphs or tables for ease of display. Tests were repeated either three or five times according to the related standards.

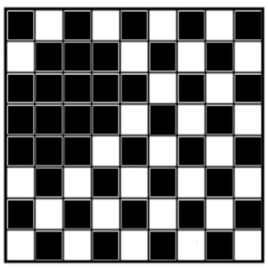

Figure 1 Weave of the blanket

Colour differences (ΔE) were also determined by using L*, a*, b* coordinates of the blankets before washing (1) and after the 5th washing (2). The colour change (ΔE) of the blankets was calculated using the formulas (Archegas et al. 2011):

$\Delta L^* = L_1^* - L_2^*$, $\Delta a^* = a_1^* - a_2^*$, $\Delta b^* = b_1^* - b_2^*$, and $\Delta E = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$

3 Results

The weight of the fabric was 537 g/m^2. Dimensional changes after repeated washing cycles are given in Figure 2 for both weft and warp directions. The dimensional change as percentage of decrease in weft direction was found higher than the % decrease in warp direction. The maximum dimensional change values were 13.33% and 7.00% for weft and warp directions, respectively.

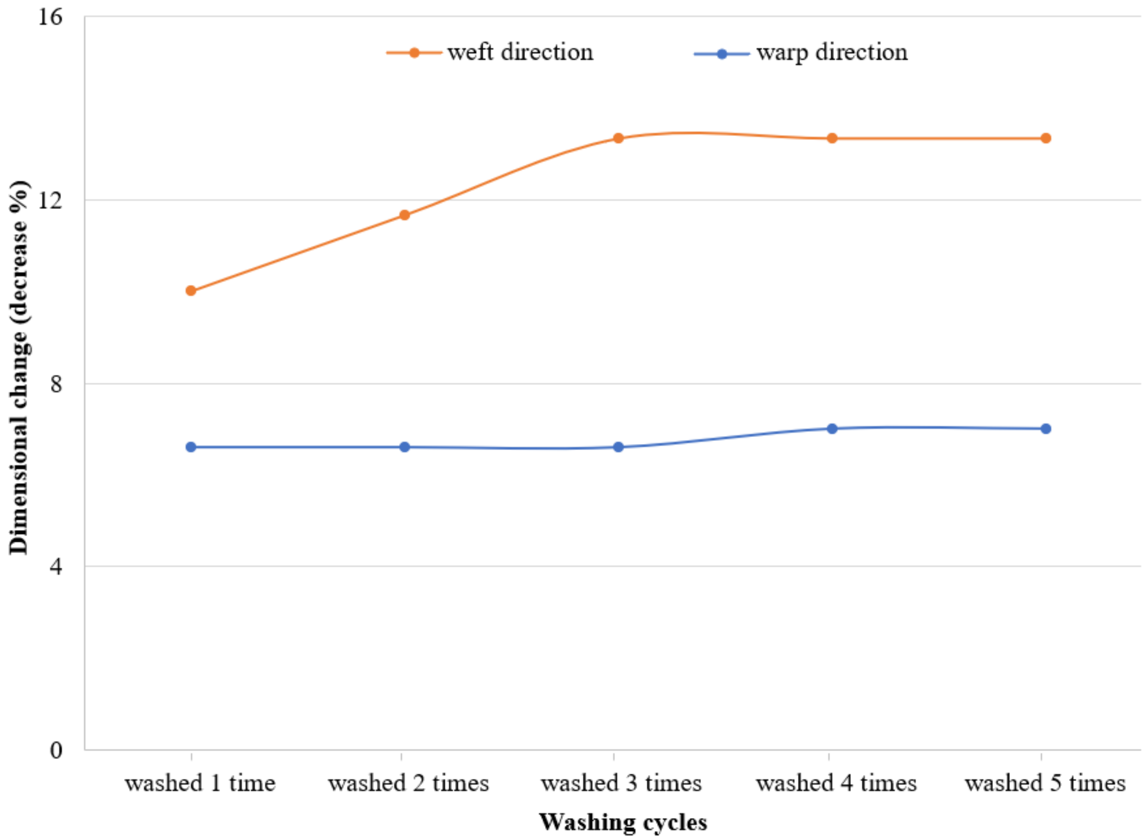

Figure 2 Dimensional changes in blanket with repeated washing cycles

The weight loss, which reached a value of 0.5% in the sample washed once, decreased with the increase in the number of washings and ended with a value of 0.3% (Figure 3). The first washing cycle was the one in which the most lint was removed. The weight loss was observed to be negligible.

The images of blanket pieces and the colour determined from the values of CIE L, a, and b are given in Table 1. As seen from the table and according to the CIE L*, a*, and b* measurements it can be concluded that there are ignorable colour changes of blankets were observed with repeated washing cycles. L* value that shows blackness and whiteness (0- black and 100-white) decreases from 54.01 to 50.96 with repeated washing cycles. The a* value that shows

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redness and greenness (positive a value-red and negative a value-green) changes between 11.36 and 10.47 range. And last, the value b* that shows yellowness and blueness (positive b value-yellow and negative b value- blue) increases from 6.52 to 7.19. As seen from the values, the colour changes are slight. ΔE value was calculated as 3,06 from CIE L*, a*, and b* values.

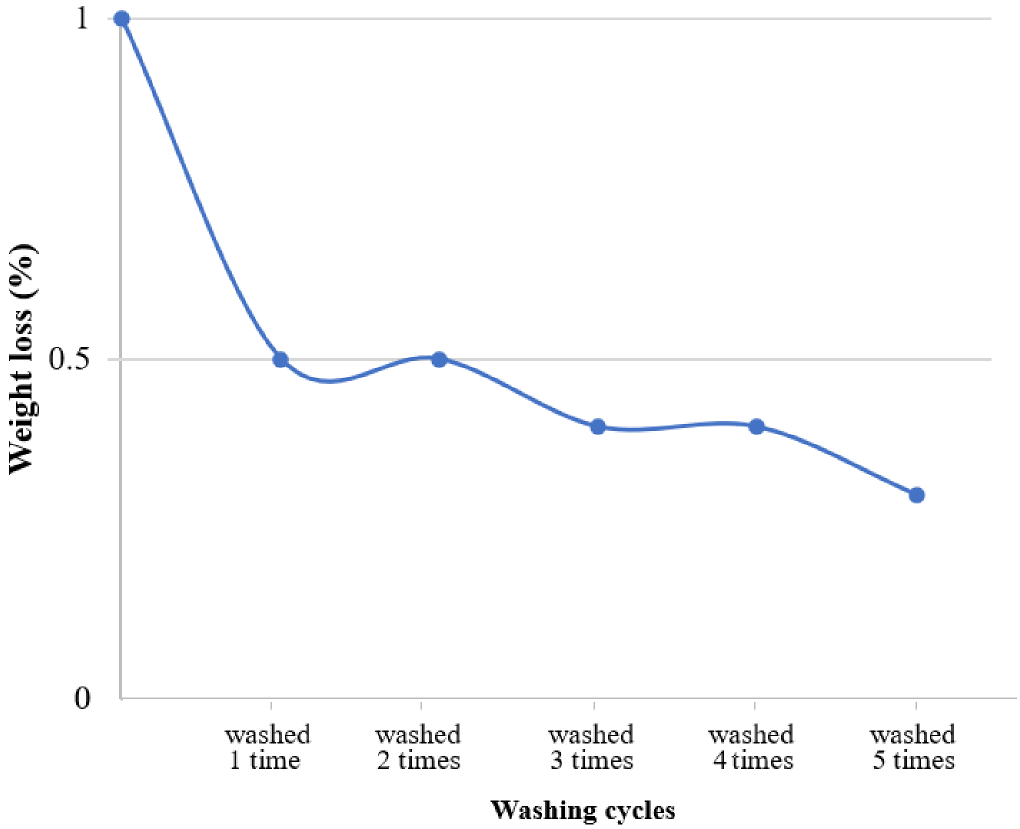

Figure 3 Weight loss of blanket with repeated washing cycles

Table 1 The photos and determined colours of samples with repeated washing cycles

	Unwashed	**Washed 1 time**	**Washed 2 times**	**Washed 3 times**	**Washed 4 times**	**Washed 5 times**
Photo of the samples						
Determined colour of the samples						

The overall results of the study revealed that the tested properties of 100% recycled blankets showed slight changes with repeated washing cycles. This result is proved by the reflectance % spectra of the samples recorded between 200-800 nm wavelength. As seen from Figure 4, the reflectance % spectra of the samples coincide.

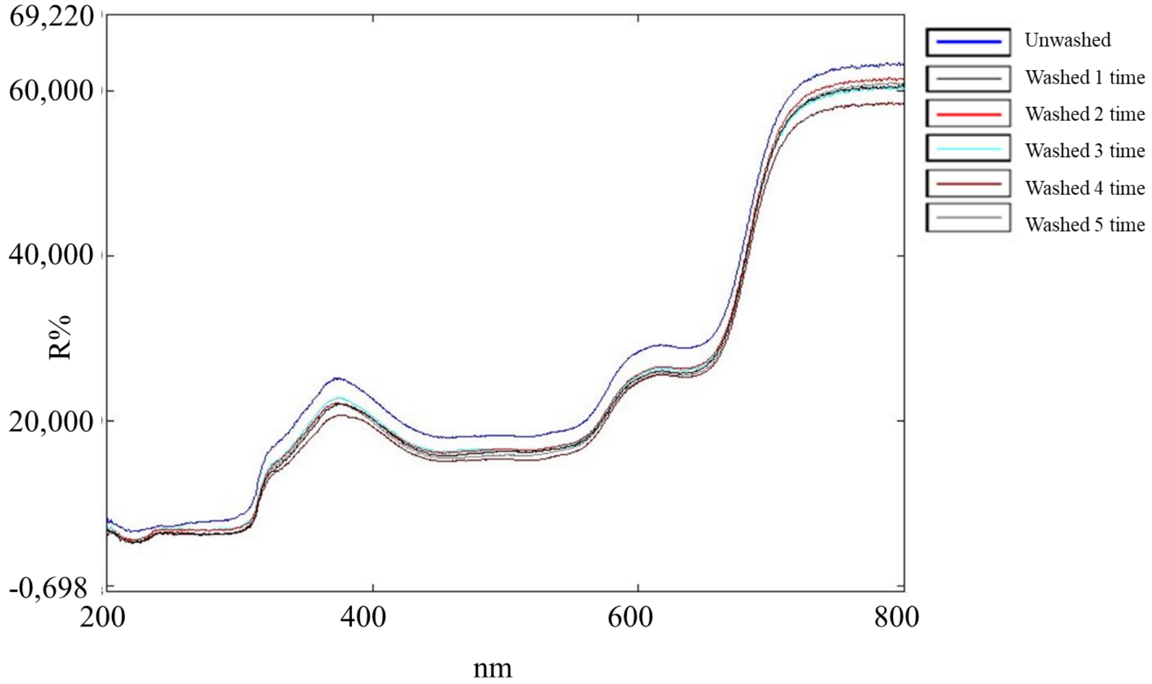

Figure 4 Reflectance (%) spectra of the samples with repeated washing cycles

Conclusion and recommendations

In this study, weight loss, dimensional change, and colour change of a commercial blanket made of recycled fibres after repeated washings were investigated. This study was carried out to emphasize the importance of recycling and sustainability. It was revealed that the use of recycled fibres did not have any negative effects in terms of the properties tested in the blankets. Up to 1% weight loss was encountered with dimensional changes of ~ 7% for the warp direction and ~ 13% for the weft direction. The ΔE value calculated from CIE L*, a*, and b* values was obtained as 3.06 at the end of five washing cycles and this value corresponds to a slight change in colour. Further studies can focus on the increased washing cycles, comparison with blankets form virgin fibres, testing other physical properties of the blankets.

Roles of author

Study Conception and Design (F.Y., G.C., G.D.T); Experimentation – Collection of data (F.Y., G.D.T); Analysis and Interpretation of Results (G.C.); Writing the Original Draft (G.C.); Writing-review and Editing (F.Y., G.C., G.D.T); Over all supervision (F.Y., G.C., G.D.T).

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Conflict of interest

The author declares that there is/are no conflicts of interest.

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